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EXPERIMENTS ON CONTROL OF ELYTRODERMA NEEDLE BLIGHT OF PINES BY SPRAYS

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Elytroderma deformans (Weir) Darker is a needle disease, with subsidiary effects on twigs of pines. The blight attacks ponderosa pine (Pinus ponderosa Laws.) over much of its range in the west and Jeffrey pine (Pinus jeffreyi Grev. & Balf.) in California. About 1945 the disease reached epidemic proportions on ponderosa pine in portions of Oregon and Idaho but it had subsided somewhat by 1954. Nevertheless it is still considered serious there and is a cause of concern in southwestern Montana. In California, the disease has been less severe than farther north but has been destructive in localized areas. Trees near Manzanita Lake in Lassen Volcanic National Park, and along the southwestern shore of Lake Tahoe, have been particularly damaged by the fungus. Tree growth has been slowed, some trees killed and the affected trees rendered very unattractive in appearance during much of the period of heaviest recreational use.

Mortality from the disease has necessitated salvage logging in severely affected stands on several national forests in Oregon and Idaho in order to prevent heavy losses. But salvage logging has resulted in no improvement in the condition of the residual stand. On several areas relogging has been necessary for two or three successive years to utilize additional trees dying from the disease or from bark beetle attacks induced by it.

In 1952 experiments were started on national-forest land near Lake Tahoe to test the possibilities of controlling the disease with fungicidal sprays. The tests were continued in 1953. It was felt that if satisfactory control by sprays could be demonstrated, the method would not only be useful in areas of particularly high value for recreational use, but might also be adapted for arresting epidemics in more extensive forest areas if practical methods of application by airplane could be worked out. This paper is to report these experiments and their negative results.

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The Fungus

Elytroderma deformans is an ascomycetous fungus belonging to the family Hypodermataceae. Like many other fungi, it has two spore forms. The time of appearance of these spore forms varies from year to year and from place to place. In general the imperfect, or pycnidial, stage is produced subepidermally on the killed portions of affected needles in May and early June. It is followed in the fall by the perfect, or ascus, stage -- the ascospores of which mature beginning about mid-September. The needles chiefly attacked are those produced the previous year on twigs that had previously borne infected foliage.

The time of year that infection takes place and the infecting spore form are not known. Since ascospores are released from the hysterothecium, or fruit body, only during moist mild weather, and the same conditions are also necessary for the germination of the spores, it was assumed that fall infection by ascospores was the normal condition. Additional evidence supporting fall infection is the fact that the needles reach full length and are mature in other respects before showing any signs of infection. Weir [1] at Priest Lake, Idaho, in 1914 performed controlled-infection experiments. He sprayed ascospores suspended in distilled water on twigs of healthy plants in the spring and then covered the twigs with paper bags. That fall the needles on the sprayed twigs turned reddish brown in spots. They became completely brown by next spring and produced mature ascospores of the fungus in May and June. It will be noted that these times of the year for discoloring of the affected foliage and for maturing of the ascospores occurred several months in advance of the normal time.

Materials and Methods

The fungicides used in this study were of two types: Those which cover the surface of the needles and act as protectants over a period of time and those which act as eradicants but give no lasting protection (table 1). Application was through a 300-gallon agitator-type commercial orchard sprayer developing 300 p.s.i. nozzle pressure, mounted on a 1½-ton flatbed truck. The plants treated were part of a young, uneven-aged stand in a cut-over area, the trees varying from seedlings of 2 feet to small poles of 50 feet in height. All were in areas heavily affected by Elytroderma deformans and had been diseased for several years before the start of the experiments.

1/ Weir, James R. Hypoderma deformans, an undescribed needle fungus of western yellow pine. Jour. Ag. Res. 6(8): 277-288. 1916.

Table 1.--Materials used in spray tests to control Elytroderma needle blight on ponderosa and Jeffrey pines

Trade Name[1]	Active Ingredients	Date Applied	Dilution in Water	Characteristics
Puratized agricultural spray	5% phenyl mercury triethanol ammonium lactate	9-29-52 8-31-53	3 qts. in 300 gal.	eradicant, penetrant
Zinc Coposil	4% copper 20% zinc	9-24-52 9-2-53	6 lbs. in 300 gal.	protectant, nonpenetrant
Orthocide 50 wettable	N-trichloromethyl thiotetrahydrophthalimide	9-23-52 9-1-53 10-5-53 10-6-53	8 lbs. in 300 gal.[2] 15 lbs. in 300 gal. 30 lbs. in 300 gal.	protectant, nonpenetrant
Opalate	Zinc dimethyl dithiocarbamate	9-26-52	6 lbs. in 300 gal.	protectant, nonpenetrant
Orthorix	Polymerized Sulphur	10-7-53	2 gal. in 300 gal.	eradicant, penetrant
Orthocide 50 wettable plus Orthorix	See above	10-8-53	10 lbs. Orthocide 2 gal. Orthorix in 300 gal.	See above
Sanilac	Summer oil	9-4-53	6 gal. in 300 gal.	protectant, nonpenetrant
Bordeaux	Copper Sulphate lime	9-25-52	12-12-300 (2-2-50) 24-24-300 (404-50)	protectant, nonpenetrant

[1] Sterox S-K as a sticker and spreader was added at the rate of 1 quart in 300 gallons of spray solution to the first 4 products used. The other products either have a similar material incorporated in them or need none. Trade names are used for simplicity; neither endorsement nor criticism of these or other products is intended.

[2] The area sprayed with 8 pounds of Orthocide 50 wettable on September 1, 1953, was sprayed a second time on October 5, using 15 pounds of the same material.

With one exception, a single application of 300 gallons of spray mixture of each material was made in late summer. This amount was enough to drench 200 to 300 trees, depending upon their size. In the one exception a second application at a higher concentration than the one first employed was made following additional recommendations received from the manufacturer. Only a single application was given in most trials because more than one application per season was considered economically impracticable for forest disease control.

No replications were made because the size of each sprayed area was rather large and the experiments were intended only as a preliminary screening procedure to indicate promising materials for further and more detailed tests.

As already indicated, the ascospores normally mature about mid-September and require moisture for germination. Moisture is also needed for the hysterothecia to open to release the ascospores. Rainfall records at Myers, California, a few miles distant, during September and early October (table 2) show sufficient rain fell before the 1952 spraying to permit infection if mature ascospores were present. For this reason the experiments were continued in 1953 when conditions were more favorable for preventative spraying.

Table 2.--Precipitation at Lake Valley Ranger Station Myers, California, for the period September 1 to October 15, 1952 and 1953

Date 1/	Precipitation Inches
1952	
September 10	0.15
September 11	0.14
September 12	0.50
September 19	0.04
September 20	0.01
September 27	0.02
1953	
September 26	0.15
October 10	0.02

1/ Measurable precipitation fell only on the indicated dates during the September 1 to October 15 period.

Results

None of the spray materials tried in 1952 and 1953 gave any indication of positive control. The first fall rains fell before spraying was started in 1952, but few mature ascospores were believed to be present during the rainy period of September 10 to 12. Nevertheless, negative results the following spring were provisionally attributed to infection during this period. In 1953 the experiments were repeated before the rains started, but the results were still negative. It must be concluded that under the conditions of application in these experiments, none of the materials tested will control Elytroderma deformans.

Discussion

The reasons for the complete failure of the materials tested to give any measure of control are obscure. Infection of needles initially protected could have occurred later in the fall, after the effectiveness of the fungicides applied had been dissipated by further rains. But a more reasonable explanation would seem to be that infection took place before the sprays were applied.

That infection occurred before spraying is indicated by another experiment. Twigs bearing diseased foliage were stripped of all visibly infected needles and then covered with sausage casing bags. The covers were placed on the twigs during the week August 10 to 14, 1953. In the spring of 1954 many dead needles were observed on the 1953 growth within these bags. The dead needles had a reddish cast characteristic of needles killed by Elytroderma. On June 2 and 3, 1954, inspection showed that 85 percent of the twigs had dead needles of the characteristic red color. Of these twigs, about 16 percent showed needles with pycnidia and nearly 4 percent had faintly visible hysterothecia. Ten percent of the branches were dead and 5 percent were uninfected. The bags were removed from the twigs at this time.

Additional observations made on September 22, 1954, showed that about 80 percent of the twigs still had dead foliage with the characteristic, though somewhat faded, color, and 37 percent of these had needles bearing well-developed hysterothecia. During the period from June to September the number of branches killed increased to 34 percent. Rodents cut an additional 10 percent of the bagged twigs during this period, and a number of the branches apparently recovered so that at this time about 10 percent of the bagged branches appear uninfected. The bags were applied in such a way that subsequent contamination from the outside is considered nil. Thus, infection must have occurred before August 10, 1953, or must have taken place subsequently from spores or other sources of infection present in or on the parts bagged at that time.

From spore-trapping experiments it has been determined that ascospores are present in limited quantities during the spring, as well as in the larger numbers found in the fall. Practically all of the limited number of ascospores that are discharged in the spring months appear before the middle of May[2], considerably before shoot growth starts on ponderosa and Jeffrey pines in the Lake Tahoe area. Any infection of the needles at this time would almost necessarily be accomplished within the buds from which the new shoots develop. The character and distribution of the new infection makes a spring ascospore source seem questionable. The pycnidiospores of the fungus develop in late May and early June, and would appear to be a more likely source of infection than the ascospores. However, definite information on the time and origin of infection under normal conditions must await the results of additional investigation, now under way, into the biology of the fungus. Until this information becomes available, further experiments on control by sprays appear inadvisable.

Summary

Commercial fungicides tested in 1952 and 1953 failed to control *Elytroderma* needle blight. The reason for this lack of control is not clear at the present time but could be due to: (1) reinfection by ascospores in the fall after the spray materials have been washed off or diluted by rain, or (2) infection in the spring or early summer before the sprays were applied by either ascospores or pycnidiospores.

2/ Lightle, Paul C. The pathology of *Elytroderma deformans* on ponderosa pine. Phytopathology 44(10): 557-569. 1954